Appendix K
Cap Amendments and Principal Threat Waste Considerations

PDI Evaluation Report

Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling

Portland Harbor Superfund Site
Portland, Oregon

AECOM Project Number: 60566335
Geosyntec Project Number: PNG0767A

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Prepared by:

AECOM

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CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
AECOM	AECOM Technical Services
BAZ	biologically active zone
cm	centimeter
DDT	dichlorodiphenyltrichloroethane
DDx	dichlorodiphenyltrichloroethane and its derivatives
DEQ	[Oregon] Department of Environmental Quality
EPA	United States Environmental Protection Agency
foc	fraction organic carbon
FS	Feasibility Study
Geosyntec	Geosyntec Consultants, Inc.
Koc	organic carbon partition coefficient
L/kg	liters per kilogram
NAPL	non-aqueous phase liquid
PCB	polychlorinated biphenyl
PDI	pre-remedial design investigation
PTW	principal threat waste
RAL	remedial action level
RAO	remedial action objective
RI	Remedial Investigation
RM	river mile
ROD	Record of Decision
Site	Portland Harbor Superfund Site
SMA	Sediment Management Area

1. INTRODUCTION

The Pre-Remedial Design Agreement and Order on Consent Group (Pre-RD AOC Group) for the Portland Harbor Superfund Site (Site) in Portland, Oregon, has developed and implemented a Pre-Remedial Design Investigation (PDI) for the Site. The Site Record of Decision (ROD) (United States Environmental Protection Agency [EPA] 2017) described a post-ROD sampling effort for the Site to delineate and better refine the sediment management area (SMA) footprints, refine the Conceptual Site Model, determine baseline conditions, and support remedial design. The PDI studies were conducted by the Pre-RD AOC Group pursuant to a PDI Work Plan (Geosyntec Consultants, Inc. [Geosyntec] 2017) as a foundational step to update current conditions since collection of data during the remedial investigation/feasibility study (RI/FS).

The Site is located on a 10-mile stretch of the lower Willamette River from river mile (RM) 1.9 upstream to RM 11.8. The Site covers approximately 2,200 acres[1] of an active industrial, commercial, and urbanized harbor and is located immediately downstream of the urban downtown. There are two reaches located immediately upstream of the Site. The Downtown Reach, which includes the urbanized area of downtown Portland, is defined by EPA as extending from RM 11.8 to RM 16.6. EPA defines the Upriver Reach as extending from RM 16.6 to RM 28.4. Collectively, RM 11.8 to RM 28.4 is referred to as the Downtown/Upriver Reach (D/U Reach).

1.1 Rationale for Cap Model Evaluation

The ROD identifies two types of principal threat waste (PTW): highly toxic (10^{-3} cancer risk) and source material (non-aqueous phase liquid [NAPL]) (EPA 2017, p. 20). PTW are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. With the exception of high concentrations of chlorobenzene and naphthalene, the ROD defined PTW at all concentrations measured at the Site as “reliably contained,” and determined that PTW left in place during remedy implementation would be addressed with reactive caps to provide *in situ* treatment (EPA 2017, p. iv).

This appendix demonstrates that sediment identified in the ROD as highly toxic PTW for polychlorinated biphenyls (PCBs) can be reliably contained under certain Site conditions and addressed by standard capping materials (e.g., sand); reactive caps are not generally necessary. The analysis in this appendix does not replace area-specific remedial design analyses but shows that EPA should include flexibility with regard to the need for augmented caps for highly toxic and reliably contained PTW in detailed remedial design and implementation.

[1] The ROD states the Site is approximately 2,190 acres and extends from RM 1.9 to RM 11.8. However, when mapped in GIS, the 2,190 acres only covers the area from RM 1.9 to 11.6 (at the end of the authorized navigation channel). The acreage from RM 1.9 up to RM 11.8 is more accurately 2,203 acres.

A review of PTW designations in RODs for other sediment Superfund sites released within the last 10 years was performed and is presented as Exhibit A. Six RODs (encompassing EPA Regions 2 and 10) were reviewed to assess if PTW levels were established. While the RODs for many of these sites designate PTW in sediments, none of the RODs presents a PTW threshold (concentration) or required remedial technologies to specifically address PTW. This review supports the findings of this appendix.

This appendix presents a review of the cap modeling conducted by EPA in its FS (EPA 2016a) for the Site to assess whether activated carbon amendments are needed in the cap in areas where PCB sediment concentrations exceed the concentration level designated by EPA as highly toxic PTW. This appendix focuses on PCBs because total PCBs have an extremely low-level designation of PTW in the ROD (200 micrograms per kilogram [µg/kg]). Other contaminants of concern classified as highly toxic PTW in the ROD will be considered in the detailed remedial design.

The scope of this review included the following:

- Review EPA's cap modeling presented in the FS and any associated discussion in the ROD for the Selected Remedy and any potential allowance in the ROD for modification of the approach during remedial design.
- Review the Responsiveness Summary (Part 3 of the ROD) for any EPA responses to questions related to the cap model and assumptions for the requirement to use carbon amendments.
- Develop an initial, Site-specific, updated cap model (with a range of input parameters, including the same input parameters and criteria used by EPA) to evaluate whether an unamended cap (i.e., without activated carbon or other amendments) would be protective under certain conditions at/above ROD PTW level concentrations in remaining sediments. The initial evaluation documented herein is limited to PCBs with a PTW threshold of 200 µg/kg, as specified by EPA.

2. REVIEW OF FS/ROD CAP MODELING METHODS AND RESULTS

2.1 ROD and FS Documentation

As noted in the discussion of Common Elements of the Alternatives in the ROD (p. 61; emphasis added):

> *…If sediment classified as **containing highly toxic PTW** is located in an area designated for capping, then a **reactive cap was assumed** for that area. All areas, including river banks, with known discharges of contaminated groundwater are assumed to require an in-river reactive cap to reduce the contaminant movement and limit potential exposures. The type and quantity of reactive material utilized*

in reactive caps will be determined during remedial design based on cap modeling and other information.

As further documented in the discussion of the Design Requirements for the Selected Remedy in the ROD (p. 113), the cap design will consider the following design elements, among others:

- "**Reactive Cap" in "PTW (Highly Toxic)" areas**: "*Cap design may require the use of activated carbon and/or other reactive material, as necessary, to meet RAOs* [remedial action objectives]."
- "**Significantly Augmented Cap" in "PTW (NAPL/Not Reliably Contained)" areas**: "*Cap design will include organoclay, other reactive material, and/or low permeability material, as necessary, to provide a sufficient chemical isolation layer to reliably contain underlying contamination (i.e., to pore water cleanup values)."*

Appendix A of the Responsiveness Summary portion of the ROD includes EPA's responses to the Potentially Responsible Party Dispute Resolutions on EPA's FS (EPA 2016a) regarding cap modeling and evaluations for PTW. EPA noted that

> *…if sediment classified as containing PTW is located in an area designated for capping, then a reactive cap will be assumed for that area to meet the preference for treatment and meet surface water applicable or relevant and appropriate requirements (ARARs). As such EPA determined what PTW may potentially be reliably contained based on modelling representative site conditions and capping options to determine the maximum concentrations of PTW material that would not result in exceedances of human health based water quality criteria.*

As further discussed below, EPA's cap modeling for PCBs presented in the FS was developed to confirm that a cap amended with activated carbon would be protective at the maximum sediment concentration (specified as 14,200 µg/kg in FS Table D7-3 [EPA 2016a]). The FS did not include modeling to determine if activated carbon would be needed in the cap at concentrations at or above the ROD PTW level (200 µg/kg).

2.2 Cap Model in the Final FS

The cap modeling conducted by EPA for documenting the protectiveness of a reactive cap (amended to include activated carbon or other reactive material) is presented in Appendix D (Supporting Information for Alternative Development) of the FS (EPA 2016a).

Limited cap modeling was presented for PCBs, benzo(a)pyrene, and dichlorodiphenyltrichloroethane (DDT) to document that a reactive cap (modeled as a 12-inch, activated carbon–amended layer overlain by 18 inches of sand) would be protective. For the EPA-designated PTW values defined as "not reliably contained" (chlorobenzene and naphthalene), modeling was conducted to support an evaluation of a "significantly augmented" cap with organoclay or other low-permeability material. Modeling was not presented by EPA to evaluate whether an unamended cap (i.e., without activated carbon) would be protective for sediments exceeding ROD PTW levels under certain conditions.

For the FS, EPA used the Excel-based "Active Cap Layer Model v4.11" capping model developed by the Reible Research Group of Texas Tech University (EPA 2016a). The model allows for the simulation of a contaminated sediment bed, an active cap layer, and a sand overlay ("conventional cap layer"). Although this relatively simplistic model can be used for FS-level evaluations, it is not the modeling software typically used for remedial design. In addition, this model used by EPA assumes linear sorption of contaminants, which is not a valid assumption for activated carbon. Another limitation of this FS model is that it does not include benthic mixing at the surface of the cap.

2.3 Cap Effectiveness Criteria

As noted in FS Appendix D: "*The point of compliance for determining reliable containment is the contaminant pore water concentration just below the sediment cap-surface at 100 years. Acceptable concentrations at this compliance point are the lower of the applicable RAO 4 or 8 concentrations.*" For PCBs, the criterion of 0.014 micrograms per liter (µg/L) in porewater, based on the Oregon Department of Environmental Quality (DEQ) surface water chronic criterion, was used by EPA for assessing compliance. Although the specific depth of the point of compliance was not specified in EPA FS Appendix D, a depth of 2 centimeters (cm) below the top of the cap was assumed based on Figures D7-1 (for chlorobenzene) and D7-2 (for naphthalene) of EPA FS Appendix D (EPA 2016a).

3. PDI UPDATED CAP MODELING

3.1 Modeling Approach

For purposes of this analysis, the CapSim 3.7 transient model (Lampert et al. 2018) developed by the Reible Research Group of Texas Tech University was used to evaluate cap effectiveness. This model is typically used for capping evaluations, including remedial designs. It allows for time-varying evaluations of contaminant transport in porewater through the cap and associated sediment concentrations. The model can include multiple sediment and cap layers with traditional porous media transport processes, including sorption (linear and non-linear, transient or local equilibrium), advection, diffusion, dispersion, multicomponent linked reactions and, critically, processes specific to the sediment-water interface, including bioturbation of both solids and porewater, deposition, consolidation, and interaction with the overlying surface water (Shen et al. 2018). As noted above in Section 1.1, this evaluation is focused on PCBs because of the extremely low-level designation of PTW in the ROD (200 µg/kg).

As further discussed below, initial model runs were conducted for an unamended cap at the PTW level using EPA's values for three of the key model input parameters (upwelling velocity, partition coefficient, and fraction organic carbon). Additional runs were conducted using other appropriate values for two of these parameters (upwelling velocity and partition coefficient).

3.2 Model Input and Assumptions

Table 1 summarizes the key model input parameters used for the evaluation of an unamended cap. Cases in which parameter values were specified for the PDI evaluation model that differ from those of EPA's FS model are discussed below.

Table 1. Summary of Model Input

Parameter	EPA's FS Appendix D (2016a)	PDI Evaluation
Upwelling/seepage velocity	110 cm/yr and higher	110, 24, and 11 cm/yr
Sediment concentration (PCBs)	Simulated max concentration (14,200 µg/kg) with activated carbon	Simulated at/above PTW (200 to 2,000 µg/kg) without activated carbon
Porewater concentration (PCBs)	Calculated based on EqP (for PCBs)	Calculated based on EqP; use porewater data in RD
Log Koc (PCBs)	4.89	4.89, 5.12
Depth of benthic mixing	Not simulated (FS model limitation)	Up to 6 inches
Cap thickness	2.5 ft	Varies (1 to 3 ft)
Cap/sediment foc	0.06% / 1.7%	0.06% / 1.7%
Cap consolidation	0 cm	0 cm
Sedimentation	0 cm	0 cm, added BAZ for select runs

Acronyms: µg/kg = microgram per kilogram; cm = centimeter; cm/yr = centimeter per year; BAZ = biologically active zone; EPA = U.S. Environmental Protection Agency; EqP = equilibrium partitioning; ft = foot; foc = fraction organic carbon; FS = Feasibility Study; Koc = organic carbon partition coefficient; PCB = polychlorinated biphenyl; PDI = Pre-Remedial Design Investigation; PTW = principal threat waste; RD = remedial design

3.2.1 Upwelling/Seepage Velocity

As noted by EPA in the discussion of cap modeling in Appendix D of the FS, "*a range of seepage velocities were evaluated (0.3, 3, and 30 cm/day), representing the minimum, average, and maximum values measured at the Site to better understand contaminant fate and transport under a range of conditions*" (EPA 2016a). Although FS Appendix D does not include the basis of these seepage velocities, information and data are included in Appendix C of the RI (EPA 2016b). The RI presents several methods for estimating groundwater flux/discharge (e.g., direct measurements of groundwater seepage rates, calculation of groundwater flux rates, and estimates based on published regional groundwater modeling). Although some estimated seepage rates presented in the RI are greater than 0.3 cm/day (110 cm/year), there are other rates documented in the RI that are less than 0.3 cm/day (e.g., 0.1 cm/day or 36 cm/year). Therefore, it is not evident why a value of 0.3 cm/day (110 cm/year) was used by EPA to represent the minimum in its cap modeling.

In addition, as stated in Appendix Hc (Capping Effectiveness and Stability Modeling) of the Lower Willamette Group's Draft Feasibility Study (Anchor QEA, LLC 2012), based on the conceptual model of groundwater flow and using Site-specific measurements from Portland Harbor, estimated Darcy (upwelling) velocities are generally correlated to locations within the channel and include lower values of 12 cm/year for cohesive sediments in the channel and 37 cm/year for cohesive sediments in channel slope areas (Table 3-3 in Anchor QEA, LLC 2012). For non-cohesive sediments, the range of estimated Darcy velocities presented in the Anchor QEA Draft FS is 120 to 365 cm/year. This draft FS (Table 3-4) also utilized Darcy velocities of 0.5 cm/year and 1 cm/year to represent river areas in the vicinity of upland sites with groundwater source controls.

For the purpose of assessing unamended caps herein, the cap model was run using three different velocities:

- 110 cm/year, which is the upwelling velocity used in EPA's FS cap model.
- 24 cm/year, which is (i) within the range of the velocities noted in the text above (12 to 37 cm/year in portions of the Site) and (ii) the velocity used for cap modeling conducted for other sites in the Lower Willamette River (Maul Foster & Alongi 2009; AECOM Technical Services [AECOM] 2017).
- 11 cm/year (10% of 110 cm/year), which is an assumed conservative upper bound of velocities in areas with groundwater source controls. As noted above, values lower than this (e.g., 1 cm/year) may be appropriate for these areas (Anchor QEA, LLC 2012).

As further discussed in Section 5 below, the upwelling velocities that will be used in each sediment management area (SMA) during remedial design may vary from these values and would be based on data and/or modeling expected to be completed for each SMA.

3.2.2 Underlying Sediment and Porewater Concentrations and Partition Coefficients

As noted in Section 2.1, EPA's cap modeling for PCBs presented in the FS was developed to confirm that a cap amended with activated carbon would be protective at the maximum sediment concentration (specified as 14,200 µg/kg in EPA FS Table D7-3 [EPA 2016a]). The underlying porewater concentration, which is used as model input, was estimated by EPA based on an equilibrium partitioning calculation using this maximum sediment concentration. EPA utilized an organic carbon partition coefficient (Koc) of 78,100 liters per kilogram (L/kg) (Log Koc = 4.89) and sediment fraction organic carbon (foc) of 1.7% in this calculation to estimate the underlying porewater concentration based on this maximum sediment concentration and for simulating sorption to organic carbon in the cap.

The CapSim modeling presented herein was used to evaluate whether an unamended cap (i.e., without activated carbon) would be protective for sediments exceeding ROD PTW levels (e.g., 200 to 2,000 µg/kg) under certain conditions. The EPA FS Koc was utilized for select model runs, and a Koc of 131,000 L/kg (Log Koc = 5.12), based on the Oregon DEQ chemical database (DEQ 2015), was used for an additional model run. For purposes of simulating an unamended cap, porewater concentrations were estimated using these Koc values, a sediment foc of 1.7%, and a range of sediment concentrations at the ROD PTW level (200 µg/kg) and above the ROD PTW level (1,000 and 2,000 µg/kg).

3.2.3 Benthic Mixing

Due to limitations of the Excel-based model used by EPA, benthic mixing was not included in EPA's FS cap model. For the CapSim modeling presented herein, a conservative depth of mixing of up to 6 inches was assumed to simulate porewater and particle biodiffusion at the surface of the cap. In addition, as further discussed below, a biologically active zone (BAZ) layer can also be simulated at the surface using CapSim for comparison of the predicted BAZ sediment layer concentration to sediment background values and/or sediment thresholds, if necessary during the remedial design.

3.2.4 Cap Thickness

For the modeling presented in the FS, EPA assumed a 1.5-foot-thick "conventional cap" (unamended sand) above a 1-foot-thick "active cap" layer with activated carbon (EPA 2016a). For the CapSim modeling presented herein, a range of unamended sand cap thicknesses of 1, 2, and 3 feet was assumed.

4. MODEL RESULTS

Unamended Cap Scenarios at ROD PTW Level. As discussed in Section 3.1, the CapSim 3.7 model was used to evaluate the effectiveness of unamended caps for PCBs. Figure 1 presents model results of predicted porewater concentrations with time at a depth of 2 cm for an estimated porewater concentration (0.15 µg/L) based on the ROD PTW sediment concentration (200 µg/kg) beneath the cap. Results show that the model runs for both 1- and 2-foot-thick unamended caps, using the upwelling velocity assumed by EPA in the FS (110 cm/yr), would exceed the water quality criterion (0.014 µg/L) in less than approximately 10 and 20 years, respectively.

Table 2. Model Input Ranges

Parameter	Range Evaluated
Upwelling/seepage velocity	11 to 110 cm/yr
Log Koc (PCBs)	4.89 to 5.12
PCB Concentration	200 to 2,000 µg/kg
Cap thickness	1 to 3 ft

Acronyms: µg/kg = micrograms per kilogram; cm/yr = centimeters per year; ft = feet; Koc = organic carbon partition coefficient; PCB = polychlorinated biphenyl

As discussed in Section 3.2.1, the cap model was also run for lower upwelling velocities of 24 cm/yr and 11 cm/yr. The range of input values evaluated in this appendix for parameters that varied from the values used in EPA's FS cap model is summarized in Table 2. Figure 1 also presents the model runs with these upwelling velocities with the estimated underlying porewater concentration (0.15 µg/L) based on the ROD PTW sediment concentration (200 µg/kg).

- For a 1-foot-thick unamended cap at an upwelling velocity of 11 cm/yr, the predicted concentration at 100 years slightly exceeds the criterion.[2]
- For a 2-foot-thick unamended cap at an upwelling velocity of 24 cm/yr, the predicted concentration at 100 years also slightly exceeds the criterion; whereas, at 11 cm/yr, the predicted concentration is well below the criterion.
- At an upwelling velocity of 24 cm/yr or lower with a 3-foot-thick unamended cap, the predicted concentration at 100 years is also below the criterion.

Therefore, at lower upwelling velocities with other model inputs as used by EPA, an unamended cap would be protective at the ROD PTW level for PCBs (200 µg/kg).

Unamended Cap Scenarios at Higher Sediment Concentrations. Figure 2 presents model runs for an unamended cap at underlying sediment concentrations higher than the ROD PTW level (1,000 and 2,000 µg/kg).

- With a 2-foot cap, an upwelling velocity of 11 cm/yr, and a sediment PCB concentration of 1,000 µg/kg (with an estimated porewater concentration 0.75 µg/L), the predicted porewater concentration at 100 years is less than the criterion.

[2] A model run for a 1-foot-thick unamended cap at the higher upwelling velocity of 24 cm/year is not shown on this figure, as the predicted concentrations would be higher than the 11 cm/year run and would also exceed the criterion in less than 100 years.

- Increasing the sediment concentration to 2,000 µg/kg (with an estimated porewater concentration of 1.5 µg/L), the predicted porewater concentration at 100 years slightly exceeds the criterion.
- For the same model run for 2,000 µg/kg (with an estimated porewater concentration of 1.5 µg/L) with a 2-foot-thick unamended cap, if the Koc is increased, as discussed in Section 3.2.2 (Log Koc = 5.12), the predicted porewater concentration at 100 years is less than the criterion.

Therefore, at lower upwelling velocities, an unamended cap would also be protective at concentrations higher than the ROD PTW level for PCBs.

Unamended Cap Scenarios with BAZ Layer. As noted in Section 3.2.3, a sediment concentration in the BAZ layer can also be simulated using CapSim for comparison to sediment background values and/or sediment thresholds, if deemed necessary during the remedial design. For the purpose of this evaluation, a 15 cm BAZ layer was assumed to be deposited on the cap over time for both a 1- and 2-foot-thick unamended cap. This BAZ layer is assumed to have an foc content similar to existing surface sediments (assumed 1.7%, as used by EPA in the FS model). The CapSim model predicted porewater concentrations at 2 cm, and predicted average sediment concentrations in the top 15 cm are shown in Figure 3 for both the EPA-assumed upwelling velocity of 110 cm/yr and for 24 cm/yr. For the model runs at 110 cm/yr, the predicted average sediment concentrations range from approximately 25 to 36 µg/kg at 50 years and from 60 to 67 µg/kg at 100 years. At a lower upwelling velocity of 24 cm/yr, the predicted average sediment concentrations are approximately 2 and 10 µg/kg at 50 and 100 years, respectively.

5. Implications for Management of ROD-Defined PTW

The following conclusions can be drawn based on the modeling results for PCBs presented above:[3]

- Unamended caps at the ROD PTW level (200 µg/kg), assuming EPA's overly conservative input (including seepage velocities greater than 110 cm/year) and porewater criterion for PCBs (0.014 µg/L), may not be protective.
- Unamended caps using more realistic and expected seepage velocities of 24 cm/year or lower and EPA's porewater criterion for PCBs (0.014 µg/L) would be protective at the ROD PTW level (200 µg/kg).
- Unamended caps using modified, but still realistic input (including seepage velocities of 11 cm/year or lower) and EPA's porewater criterion for PCBs (0.014 µg/L), would be

[3] The modeling presented in this appendix is for the purpose of evaluating the effectiveness of an unamended cap for PCBs at and near the ROD PTW level. The modeling and the associated input to be used for the remedial design may vary from what is specified herein.

protective at concentrations above the ROD PTW level for PCBs (up to 2,000 µg/kg and potentially higher).

In addition, the modeling supports cap thicknesses that are less than the EPA-assumed cap thicknesses presented in the FS and ROD.

The ROD statutory determinations section states: "*The Selected Remedy will address all principal threat waste (PTW) by excavation and off-site disposal or, if left in place, with augmented reactive caps to provide in-situ treatment*." The ROD later states that cap design in PTW (highly toxic) areas "***may*** *require the use of activated carbon and/or other reactive material,* ***as necessary****, to meet RAOs*" (emphasis added). The FS and ROD included the assumption that activated carbon would be used to amend caps in areas with PCB concentrations greater than 200 µg/kg. The analyses reported in this appendix indicate that, under certain conditions, an unamended cap would be protective, and activated carbon would not be needed with PCB concentrations at and above the ROD PTW level. Therefore, future remedial designs should include an evaluation of unamended caps, including when sediments beneath the cap exceed the ROD PTW levels. Based on these model results, this appendix recommends maintaining the ROD remedial action level (RAL) of 1,000 µg/kg in the navigation channel without downward adjustment of the RAL to accommodate the ROD PTW criterion of 200 µg/kg.

Although the analyses and modeling presented herein are focused on PCBs, an unamended cap should also be evaluated during remedial design for the other contaminants designated as "highly toxic" with EPA-designated PTW values in ROD Table 6 (i.e., dichlorodiphenyltrichloroethane and its derivatives [DDx], carcinogenic polycyclic aromatic hydrocarbons, and dioxin/furans). In addition, the EPA-designated PTW values defined as "not reliably contained" (i.e., concentrations greater than 320 µg/kg for chlorobenzene and 140,000 µg/kg for naphthalene, as presented in ROD Table 7), which were derived from EPA's FS cap model, should be reassessed during remedial design using a more appropriate model such as the CapSim model (which, unlike the model used by EPA in the FS, incorporates non-linear sorption for activated carbon) and area-specific input parameters. As noted above, EPA assumed that a "significantly augmented cap" that would include organoclay, other reactive material, and/or low-permeability material, as necessary, in addition to an activated carbon layer, would be needed to provide sufficient chemical isolation to reliably contain underlying contamination above these PTW levels for chlorobenzene and naphthalene. Therefore, in addition to an evaluation of the need for activated carbon for "PTW (highly toxic)" areas, EPA should also allow flexibility in determinations of the PTW levels for "not reliably contained" using the CapSim model and area-specific data (e.g., upwelling, porewater concentrations) and thus the need for a "significantly augmented cap."

The ROD contemplates modeling as part of detailed remedial design, and this analysis demonstrates that EPA should allow flexibility in determinations regarding the need for cap amendment for "highly toxic" PTW as well as determinations of the PTW levels for PTW designated as “not reliably contained.” Remedial design for capping areas within SMAs should include the following considerations:

- Separate models/design evaluations for distinct capping areas.
- Area-specific data, such as:
  - Sediment and porewater beneath cap
  - Upwelling velocities, including any current or planned hydraulic control measures along shoreline
  - Cap material sources
- Consensus on modeling approach:
  - Initial model runs assume a range of cap thicknesses without activated carbon (i.e., unamended cap). If the unamended cap is protective in a cap design area with underlying sediment exceeding ROD PTW levels, inclusion of amendments would not be required.
  - If activated carbon is needed in select areas, thinner caps and lower activated carbon dosages than assumed by EPA in the FS modeling would be considered (and incorporate non-linear sorption with Freundlich parameters for activated carbon in CapSim).
  - Assess model sensitivities to key parameters.

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FIGURES

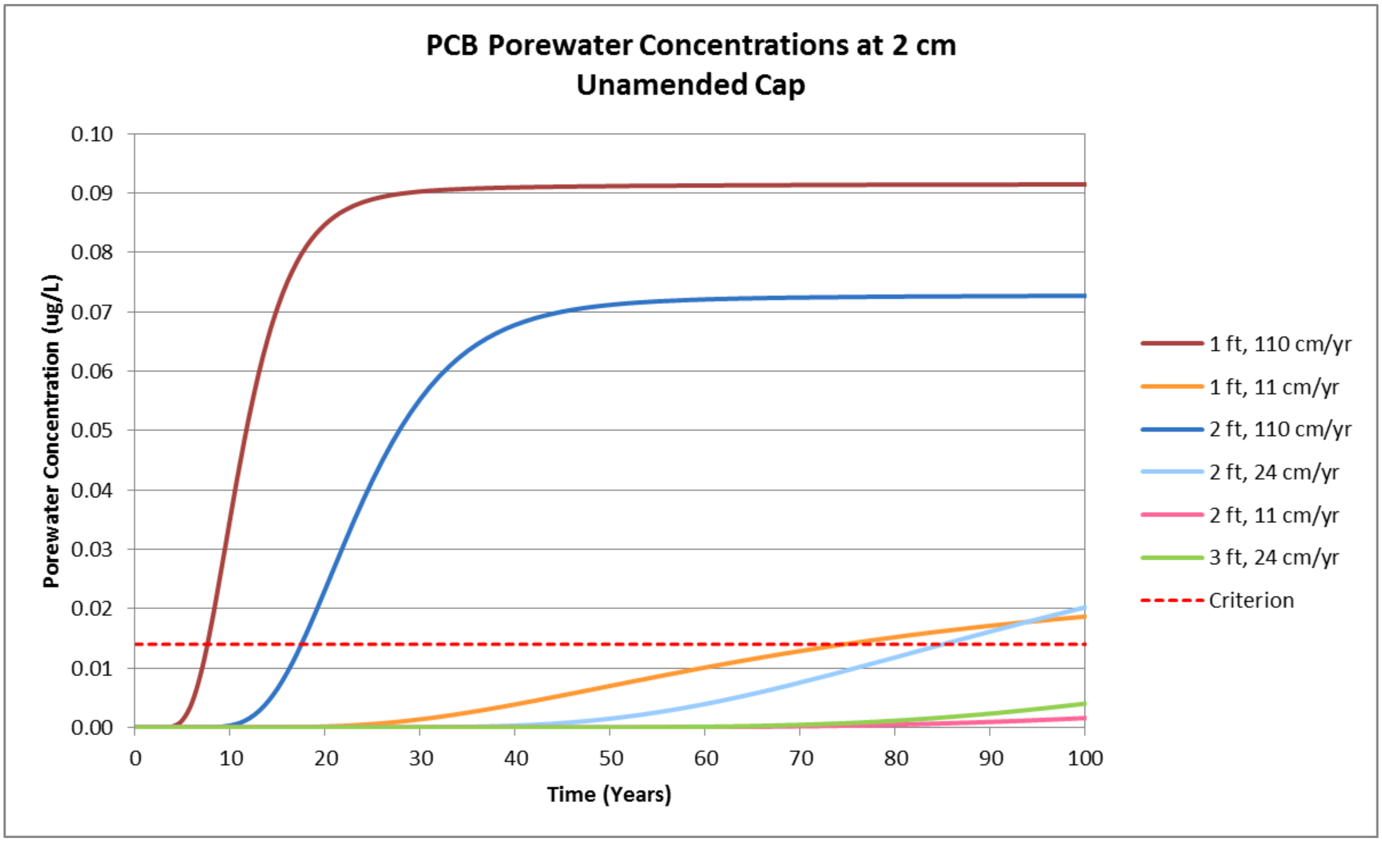


Figure 1. Model Results for PCBs with Estimated Porewater at PTW Sediment Concentration (200 µg/kg) for Unamended Cap

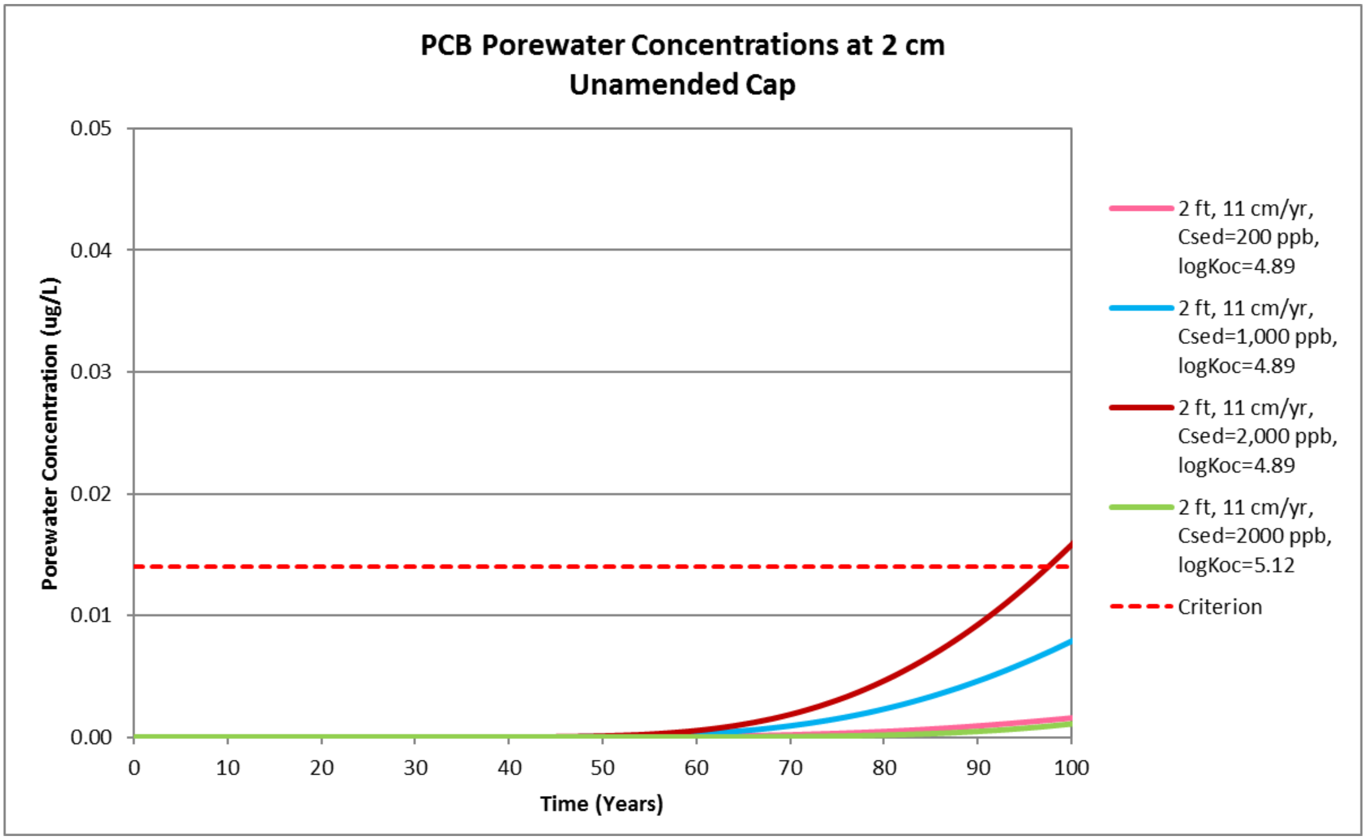
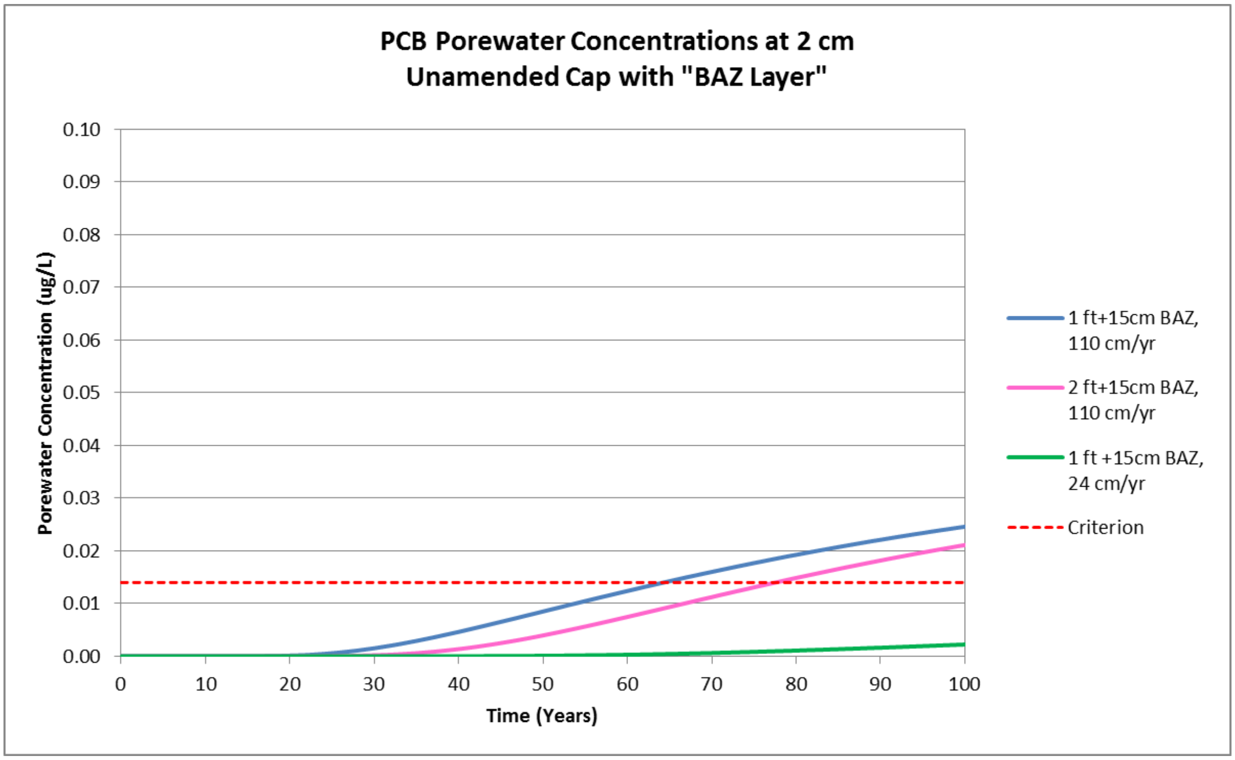


Figure 2. Comparison to Model Results for PCBs Based on Estimated Porewater at Sediment Concentrations of 1,000 and 2,000 µg/kg for Unamended Cap



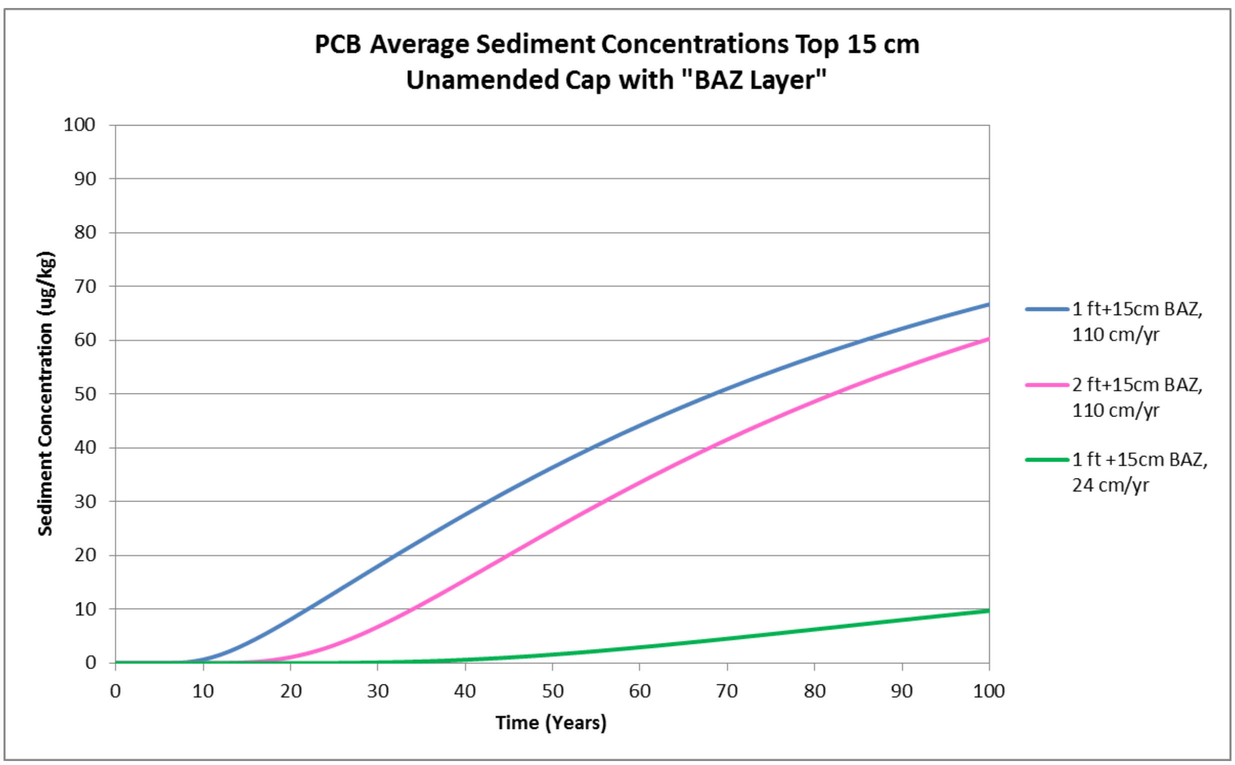


Figure 3. Model Results for PCBs with Estimated Porewater at PTW Sediment Concentration (200 µg/kg) for Unamended Cap with “BAZ Layer”

EXHIBIT A

PTW Classifications at Other Sediment Sites

EXHIBIT A
Review of Principal Threat Waste (PTW) Levels Noted in Records of Decision (RODs) for Other Sediment National Priority List (NPL) Sites

With the exception of the McCormick and Baxter Site, which is within the Portland Harbor Superfund Site, only sediment RODs released within the last 10 years are discussed herein.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA) REGION 10

1. McCormick and Baxter Creosoting Company (EPA Region 10, March 1996)

RESPONSIVENESS SUMMARY

"*COMMENT: The area along the river is a prime concern of the community. The proposed plan should designate areas of high concern as principle threats and should reconsider treatment or removal options for these sediment.*

RESPONSE: The revised FS, Section 3.3.1 provides the rationale for not identifying sediments as principal threats under the criteria identified in the NCP. The FS states that surface sediment poses a direct contact risk and exhibits toxicity to test organisms in localized areas, but has less potential for exposure to humans than surface soil. The sediment does not appear to be significantly adversely affecting the broader Willamette River ecosystem, or pose a high risk for mobilization out of the nearshore area at the site. Under these conditions, use of engineering controls, such as capping, is consistent with EPA's national strategy for contaminated sediment. The long term monitoring and institutional controls which are elements of the selected remedy will ensure protection of human health and the environment. The monitoring program will include provisions for timely assessment and repairs of damage from events such as the February 1996 flood."

The ROD for this site, which is located within the Portland Harbor Superfund Site, does not identify any PTW levels (concentrations) and does not include mobile non-aqueous phase liquid (NAPL) as PTW in sediments. The ROD states that engineering controls (e.g., capping) along with long-term monitoring are sufficient to address higher concentration materials.

2. Lower Duwamish Waterway ROD (EPA Region 10, November 2014)

ROD Section 11 on Principal Threat Wastes states: "*EPA has determined that the contaminated sediments in the LDW outside of the EAAs are not highly mobile or highly toxic. No direct evidence of any significant amounts of non-aqueous phase liquids has been found in LDW sediments. The maximum concentrations detected for the four human health risk drivers in surface and subsurface sediment outside of the EAAs are:*

- *11,000 µg TEQ/kg dw for cPAHs*

- *2,100 ng TEQ/kg dw for dioxins/furans*
- *890,000 µg/kg dw for total PCBs*
- *2,000 mg/kg dw for arsenic*

  Direct contact risks are low relative to seafood consumption risks (maximum direct contact RME excess cancer risk is 2 × 10^{-4}, as compared to an excess cancer risk of 3 × 10^{-3} for seafood consumption). For PCBs and dioxins/furans, the primary threat comes from bioaccumulation through exposure of aquatic receptors (e.g., fish and shellfish). Once contaminated sediment is capped or dredged, exposure through seafood consumption will cease.

  Most alternatives, including the Selected Remedy, would utilize ENR/in situ treatment if pilot testing shows that the technology will be effective."

The ROD does not identify any PTW levels (concentrations) for these contaminants based on either direct contact risks or seafood consumption risks. In addition, the ROD allows for placement of engineered sediment caps on highly contaminated sediments where there is sufficient water depth for a cap.

3. **Wyckoff/Eagle Harbor Superfund Site Operable Units 1, 2, and 4; ROD Amendment (EPA Region 10, May 2018)**

ROD Amendment (RODA) Section 11 on Principal Threat Wastes states:

"In the 1994 ROD for OU1, EPA determined that 'The principal threat in the East Harbor is defined as subtidal sediments containing free-phase oily contamination.'" This determination has not changed. Sediments contaminated with oily creosote, described in this RODA as NAPL-contaminated sediments, are principal threat waste.

All active cleanup alternatives described in this RODA require excavation and/or dredging to remove NAPL-contaminated sediment from the top 2 feet of the intertidal beaches. The NAPL that remains in the beaches in present in thin, diffuse layers and "stringers" and is not amenable to collection through wells. The most effective way to remove the NAPL is to dredge the sediment. Once dredged, the sediment will be treated if necessary to reduce contaminant mobility prior to transport and disposal in a landfill. Treatment of the remaining NAPL contaminated sediment will be accomplished through the use of reactive materials in the bottom layer of the cap. Reactive materials, for example oleophillic clay or activated carbon, will reduce contaminant mobility and help ensure containment of contaminants that will be left beneath the cap. During predesign sampling, reactive materials will be tested to determine the optimum type and amount. During design, the best placement method will also be determined."

"The NCP establishes the expectation that treatment will be used to address the principal threats posed by a site whenever practicable (40 CFR 300.430[a] [1] [iii] [A]). As discussed in Section 11, EPA determined that sediments contaminated with oily creosote NAPL are principal threat

waste. The NAPL that remains in the beaches is present in thin, diffuse layers and "stringers" that cannot be treated effectively in-situ. The Selected Remedy, therefore, includes dredging to remove contaminated sediments from the beaches.

Once dredged, NAPL contaminated sediment will be dewatered and the water handled in the upland portions of the site through infiltration and/or treatment in the groundwater treatment plant. The sediment will be stabilized as needed before it is transported to off-site disposal. Stabilization will reduce NAPL mobility and toxicity, but it will not destroy the contaminants or reduce contaminant volume. The Selected Remedy will leave some principal threat material in place beneath the sediment caps. The cap design includes a reactive layer that will reduce contaminant mobility and protect people and benthic organisms exposed to the cap's upper layer.

Further treatment to destroy contaminants in the dredged sediment will not be cost-effective. Additional removal of principal threat waste, evaluated in Alternative 5, was determined to be impractical due to high cost, adverse short-term impacts, and implementation challenges. The Selected Remedy will use treatment to address principal threats to the extent practicable in the intertidal beaches at the Wyckoff Site."

The ROD does not identify any PTW levels (concentrations). In addition, the remedy allows NAPL PTW to remain in sediment below 2 feet in intertidal beach areas and in areas of deeper water beneath an engineered cap with a reactive layer.

EPA REGION 2

4. Gowanus Canal (EPA Region 2, September 2013)

ROD Section on Principal Threat Wastes (p. 78) states: "*Elevated contaminant concentrations and visual evidence of the presence of NAPL exist in the canal. The RI indicated that the NAPL and contaminated sediments are mobile, at least when disturbed; have high concentrations of toxic compounds; and present significant risks. Therefore, they are characterized as principal threat wastes."*

The selected remedy addresses source materials constituting principal threats by removing the entire accumulated sediment column, thermally treating the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal and applying ISS in targeted NAPL areas of native sediment, thereby satisfying the preference for treatment."

The ROD does not identify any PTW levels (concentrations).

5. Lower Passaic River, Lower 8 Miles ROD (EPA Region 2, March 2016)

ROD Section 11 on Principal Threat Wastes states: "*The dioxin, PCB and other COC concentrations in sediments throughout the lower 8.3 miles of the Lower Passaic River are present at levels contributing to* 10^{-3} *risks for humans consuming fish and crab caught in the lower 8.3* *miles, a risk level that can be used as a basis for identifying principal threat waste. Although the engineering and sediment transport modeling work done as part of the FFS has determined that the deeper sediment, despite its toxicity, can be reliably contained, EPA nevertheless considers the most highly contaminated sediments as principal threat wastes at the site. As such, EPA has considered treatment as a component of dredged material management. EPA does not believe that additional treatment of all the sediment in the lower 8.3 miles is practicable or cost effective, given the high volume of sediment, the number of COCs that would need to be addressed, and the lack of applicable treatment technologies."*

The ROD does not identify any PTW levels (concentrations) for these contaminants.

6. Grasse River PCBs Superfund Site (EPA Region 2, April 2013)

"*At the Site, the contaminated sediment from T1 to T21 and the contaminated surface sediment from T21 to T72 are considered to be a potential source of PCBs to surface water and fish and present a significant risk to human health and the environment should exposure occur. Although EPA believes that the contaminated sediments in the main channel can be reliably contained under an armored cap and main channel cap, EPA nevertheless characterized the most highly contaminated sediments as principal threat wastes at the Site. EPA does not believe that treatment of the principal threat wastes is practicable or cost effective given the widespread nature of the sediment contamination and the high volume of sediment that would need to be addressed."*

The ROD does not identify any PTW levels (concentrations).

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